coast of Ireland in the first cruise, the proportion given by the late Mr. David Forbes was only about one-half, while in another sample from 2435 fathoms, dredged off the south coast of Ireland in the second cruise, Mr. Hunter found a little over 60 per cent.

As to a mysterious deposit called *Bathybius*, Mr. Buchanan, who had charge of the chemical work on board the *Challenger*, proved by careful and repeated analysis that this substance was not organic; and he "determined it to be sulphate of lime, which had been eliminated from the sea-water, always present in the mud, as an amorphous precipitate on the addition of spirit of wine." Mr. Murray came to the same conclusion; and the lifeless and inorganic nature of *Bathybius* may now be considered settled. This gelatinous slime was once imagined to be primordial, and to constitute the basis of life. But the sea-bed is the tomb of past generations, not the womb of creation.

10. *Geological.*—The late Sir Charles Lyell says, in the sixth edition of his "Elements of Geology" (1865), "that white chalk is now forming in the depths of the ocean, may now be regarded as an ascertained fact, because the *Globigerina bulloides* is specifically undistinguishable from a fossil which constitutes a large part of the chalk of Europe." He assumed that the *Globigerina* inhabited the ooze on the sea-bed. Edward Forbes and other geologists had initiated and adopted the same view that Chalk was a deep-sea deposit. In my Presidential Address to the Biological Section of the British Association at the Plymouth Meeting in 1877, I ventured to question the validity of this theory, and especially that which my colleague and friend Sir Wyville Thomson started as to the "continuity of the Chalk" from the Cretaceous to the present period. I there endeavoured to show that the Chalk differed in composition from the Atlantic mud, and that the fauna of the Chalk formation represented shallow and not deep water. My view has, I am glad to say, been to some extent admitted by Sir Wyville Thomson in his "Report on the Scientific Results of the Voyage of H.M.S. *Challenger*," when he speaks (pp. 49 and 50) of the belt of "shallower water" during the Cretaceous period. At all events, Mr. Wallace has lately accepted and confirmed my opinion.[1] It is highly probable that the Gault, which underlies the Chalk and is the lowest member of the Upper Cretaceous formation, was a deep-water deposit, because it abounds in small shells of the *Arca* and *Corbula* families, which are wanting in the Chalk; as well as in Ammonites and other free-swimming Cephalopods.

Mr. Sollas, indeed, in his paper "On the Flint Nodules of the Trimmingham Chalk" (*Annals and Magazine of Natural History* for December, 1880) believes that some deep-sea mud is analogous with the Chalk. He is aware that the former contains siliceous organisms and the latter none; and he supposes that the flints had been in some way derived from these organisms. But how flints originated and were formed is still a vexed question. Mr. Sollas is perhaps our best authority on Sponges; but he states (p. 444) that "the bottom-water of the sea is remarkably free from organic matter." This statement does not agree with the analyses of the bottom-water of the sea which were made by Mr. Lant Carpenter, Dr. Frankland, and Mr. Buchanan, the chemist of the *Challenger*, nor with the observations of Sir Wyville Thomson in his "Depths of the Sea," in which he says (p. 46) "the bottom of the sea is a mass of animal life."

Several species of Mollusca which were previously known as fossil only, and were supposed to be extinct, have lately been dredged by myself and others from the bottom of the Atlantic. Some of these same species had been described and figured by Prof. Seguenza of Messina from Pliocene beds in Sicily. I have no doubt that many more, perhaps all, of such fossil species will be hereafter discovered in a living state by means of deep-sea explorations.

Some geologists, and especially of late years, have advocated the theory that oceans have continued for an enormously long period to occupy the same areas that they still occupy. Mr. Darwin was, I believe, the first to broach this idea. He says, in the chapter "On the Imperfection of the Geological Record," "We may infer that where our oceans now extend oceans have extended from the remotest period of which we have any record; and, on the other hand, that where continents now exist large tracts of land have existed, subjected, no doubt, to great oscillations of level, since the earliest Silurian period." There does not seem to be any fact adduced or reason given for either of the above inferences.

[1] "Island Life."

If the present oceans and continents have remained unchanged since the Silurian period, how can we account for the wide-spread distribution of fossiliferous formations, Palæozoic, Mesozoic, Cainozoic or Tertiary, and Quaternary or Recent, miles in thickness, all over Europe, Asia, Africa, Australasia, and New Zealand? All oceanic islands are of volcanic origin; but some of them contain Miocene fossils. These formations are chiefly marine, both deep water and shallow; and they necessarily imply the presence of oceans in those parts of the globe which are now continents and dry land. All the "secrets of the deep" will probably never be revealed to man, nor is he likely to know what terrestrial formations underlie the floor of the mid ocean.

In my paper "On the Occurrence of Marine Shells of Existing Species at different Heights above the Present Level of the Sea," which was published in the *Quarterly Journal of the Geological Society* for August 1880, I stated that many existing species of Mollusca which inhabit great depths only are found in a fossil state at considerable heights above the present level of the sea, so as to show an elevation equal to nearly 12,000 feet, and that such elevation must have taken place at a very late and comparatively recent stage of the Tertiary or Post-Tertiary epoch. In the face of facts like this, can we rightly assign to the present oceans that geologically remote antiquity which is claimed for them?

11. *Incidental.*—Clarence's dream of wrecks, corpses, wonderful treasures, and

> reflected gems
> That woo'd the slimy bottom of the deep,
> And mock'd the dead bones that lay scatter'd by,"

has not yet, I believe, been realised by any dredger. I have in this way explored for between forty and fifty years all our own seas, besides a considerable part of those on the coasts of North America, Greenland, Norway, France, Spain, Portugal, Morocco, and Italy; but I have never found anything of value except to a naturalist, nor any human bone, although many thousand human beings must have perished in those seas.

12 *Concluding Remarks.*—To give a better idea of the ocean and of its life in the depths as well as on the surface, let me strongly recommend my hearers to read Mr. Moseley's admirable volume entitled "Notes of a Naturalist on the *Challenger*." His graphic account of this marvellous voyage far surpasses in interest (to say nothing of accuracy) every work of fiction or imagination, and it has not the melancholy dulness of most books on history and travels.

The subject of this lecture is inexhaustible; and, as our knowledge of it becomes more extended, we must continually say with Seneca, "Our predecessors have done much, but have not finished. Much work yet remains, and much will remain; nor to any one, born after a thousand ages, will be wanting the opportunity of still adding something." Such increase of knowledge must tend to confirm our acknowledgment, with a reverential awe, of that Great Creator whose wondrous works are dimly seen in every form of life, marine and terrestrial, and especially in

> "all that glides
> Beneath the wave, yea, in the wave itself,
> And mighty waste of waters."

GAS AND ELECTRICITY AS HEATING AGENTS[1]

I.

ON March 14, 1878, I had the honour of addressing you "On the Utilisation of Heat and other Natural Forces." I then showed that the different forms of energy which Nature has provided for our uses had their origin, with the single exception of the tidal wave, in solar radiation; that the forces of wind and water, of heat and electricity, were attributable to this source, and that coal formed only a seeming and not a real exception to the rule,—being the embodiment of a fractional portion of the solar energy of former geological ages.

On the present occasion I wish to confine myself to one branch only of the general subject, namely, the production of heat energy. I shall endeavour to prove that for all ordinary purposes of heating and melting, gaseous fuel should be resorted to for the double reason of producing the utmost economy and of doing away with the bugbear of the present day, the smoke nuisance; but that for the attainment of extreme degrees of heat

[1] A lecture by C. William Siemens, D.C.L., LL.D., F.R.S., on January 27, in St. Andrew's Hall, Glasgow, under the auspices of the Glasgow Science Lecture Association.

the electric arc possesses advantages unrivalled by any other known source of heat.

Carbonaceous material such as as coal or wood is practically inert to oxygen at ordinary temperatures; but if wood is heated to 295° C. (593° F.), or coal to 326° C. (617° F.), according to experiments by M. Marbach, combination takes place between the fuel and the oxygen of the atmosphere, giving rise to the phenomenon of combustion. It is not necessary to raise the whole of the combustible materials to this temperature in order to continue the action; the very act of combustion when once commenced gives rise to a great development of heat, more than sufficient to prepare additional carbonaceous matter, and additional air for entering into combination; thus a match suffices to ignite a shaving, and that in its turn to set fire to a building.

The first effect of combustion is therefore to heat the combustible and the air necessary to sustain combustion to the temperature of ignition, but in dealing with the combustible called coal other preparatory work has to be accomplished besides mere heating in order to sustain combustion. The following is an analysis from Dr. Percy's work on "Fuel" of a coal from the Newcastle district:—

Carbon	81·41	Nitrogen	2·05
Hydrogen ...	5·83	Sulphur	0·74
Oxygen	7·90	Ash	2·07

which shows at a glance that nearly 16 per cent. of the total weight consists of such permanent gases as hydrogen, oxygen, and nitrogen. These gases are partly occluded or absorbed within the coal, but are also combined with carbon-forming volatile compounds, such as the hydrocarbons and ammonia, so that when coal is subjected to heat in a closed retort, as much as 35 per cent. passes away from the retort in a gaseous condition and as vapour of water, partly to condense again in the form of tar, and of ammoniacal liquor, and partly to pass into the gas mains as illuminating gas, a mixture mainly of marsh gas (Ch_4), olefiant gas (C_2H_4), and acetylene (C_2H_2), its value as an illuminant depending upon the percentage of the last two constituents rich in carbon. The result of the distillation of a ton of coal will be as follows, from data with which Mr. A. Upward has kindly supplied me:—

	cwt.
Coke	13·60
Tar	1·20
Ammoniacal Liquor	1·45
Gas	3·15
Carbonic acid	0·18
Sulphur removed by purifying	0·30
Loss	0·12

So great is the loss of heat sustained in an ordinary coal fire, in consequence of the internal work of volatilisation, that such a fire is scarcely applicable for the production of intense degrees of heat, and it has been found necessary to deprive the coal in the first place of its volatile constituents (to convert it into coke) in order to make it suitable for the blast furnace, for steel melting, and for many other purposes where a clear intense heat is required.

In the ordinary coke oven the whole of the volatile constituents are lost, and each 100 lbs. of coal yield only 66 lbs. of coke, including the whole of the earthy constituents which on a large average may be taken at 6 lbs., leaving a balance of 60 lbs. of solid carbon. In burning these 60 lbs. of pure carbon, 220 lbs. of carbonic anhydride (CO_2) are produced, and in this combination $60 \times 14{,}500 = 870{,}000$ heat units (according to accurate determinations by Favre and Silbermann, Dulong, and Andrews) are produced.

The 34 per cent. of volatile matter driven off yield, when the condensible vapours of water, ammonia, and tar are separated, about 16 lbs. of pure combustible gas (being equal to about 10,000 cubic feet per ton of coal), which in combustion produce $16 \times 22{,}000 = 352{,}000$ heat units. The escape of these gases from the coke oven constitutes a very serious loss, which may be saved, to a great extent at least, if the decarburisation is effected in retorts. The total heat producible from each 100 lbs. of coal is in that case $870{,}000 + 352{,}000 = 1{,}222{,}000$ or 12,220 units per lb. of coal. Deduction must, however, be made from this for the heat required to volatilise 34 lbs. of volatile matter for every 100 lbs. of coal used, and also for heating the coke to redness, or say to 1000° F. Considering the multiplicity of gases and vapours produced it would be tedious to give the details of this calculation, the result of which would approximate to 60,000 heat units, or 600 units per lb. of coal treated.

We thus arrive at $12{,}200 - 600 = 11{,}600$ heat units as the maximum result to be obtained from 1 lb. of best coal. Considering, however, that the coal commonly used for industrial purposes contains more ashes and more water than has been here assumed, a reduction of say 10 per cent. is necessary, and the calorific power of ordinary coal may fairly be taken at 10,500 units per. lb.

In applying this standard of efficiency to actual practice it will be found that the margin for improvement is large indeed. Thus in our best steam-engine practice we obtain one actual HP. with an expenditure of 2 lbs. of coal per hour (the best results on record being 1·5 lb. of coal per Indicated HP.) A HP. represents $33{,}000 \times 60 = 1{,}980{,}000$ foot-lbs. per hour, which is $\frac{1{,}980{,}000}{2} = 990{,}000$ foot-lbs., or units of force, per lb. of fuel. Dr. Joule has shown us that 772 foot-lbs. represent one unit of heat, and 1 lb. of coal therefore produces $\frac{990{,}000}{772} = 1282$ units of heat instead of 10,500, or only one-eighth part of the utmost possible result.

In melting steel in pots in the old-fashioned way, as still practised largely at Sheffield, $2\frac{1}{2}$ tons of best Durham coke are consumed per ton of cast steel produced. The latent and sensible heat really absorbed in a pound of steel in the operation, does not exceed 1800 units, whereas $2\frac{1}{2}$ lbs. of coke are capable of producing $13{,}050 \times 2{\cdot}5 = 32{,}625$ units, or 18 times the amount actually utilised.

In domestic economy the waste of fuel is also exceedingly great, but it is not easy to give precise figures representing the loss of effect, owing to the manifold purposes to be accomplished, including cooking and the heating and ventilation of apartments. If ventilation could be neglected, close stoves such as are used in Russia would unquestionably furnish the most economical mode of heating our apartments; but health and comfort are after all of greater importance than economy, and these are best secured by means of an open chimney. Not only does the open chimney give rise to an active circulation of air through the room, which is a necessity for our well-being, but heat is supplied to the room by radiation from the incandescent material instead of by conduction from stove surfaces; in the one case the walls and furniture of the room absorb the luminous heat rays, and yield them back to the transparent air, whereas, in the latter case, the air is the first recipient of the stove heat, and the walls of the room remain comparatively cold and damp, giving rise to an unpleasant musty atmosphere, and to dry rot or other mouldy growth. The adversaries of the open fireplace say that it warms you on only one side, but this one-sided radiant heat produces upon the denizens of this somewhat humid country, and indeed upon all unprejudiced people, a particularly agreeable sensation; which is proof I think of its healthful influence. The hot radiant fire imitates indeed the sun in its effect on man and matter, and before discarding it on the score of wastefulness and smokiness, we should try hard, I think, to cure it of its admitted imperfections.

If incandescent coke is the main source of radiant heat, why, it may be asked, do we not resort at once to coke for our domestic fuel? The reasons are twofold: the coke would be most difficult to light, and when lighted would look cheerless without the lively flickering flame.

The true solution consists, I venture to submit, in the combination of solid and gaseous fuel when brought thoroughly under control, by first separating these two constituents of coal. I am bold enough to go so far as to say that raw coal should not be used as fuel for any purpose whatsoever, and that the first step toward the judicious and economic production of heat is the gas retort or gas producer, in which coal is converted either entirely into gas, or into gas and coke, as is the case at our ordinary gas works.

When in the early part of the present winter London was visited by one of its densest fogs, many minds were directed towards finding a remedy for such a state of things. In my own case it has resulted in an arrangement which has met with a considerable amount of favour and practical success, and I do not hesitate to recommend it to you also for adoption. Its general application would, as regards dwelling-houses, make our town atmosphere as clear as that of the surrounding country. If it can be shown that the arrangement may be easily and

cheaply applied, that it will relieve our housemaids of the most irksome portion of their daily work in laying fires and cleaning grates, and that a warm and cheerful fire can be made at a considerably cheaper rate than when using coal, you will admit, I hope, that the proposal is worthy of a trial.

In outward appearance my fire-grate, which I have not made the subject of a patent, and which may therefore be put up by any grate or gas-fitter without restraint, is very similar to the ordinary coal-grate; the latter may indeed be converted into the smokeless grate at a very trifling cost. The essential features of this grate are that solid carbonaceous fuel, such as coke or anthracite, are used in combination with as much gas as is found necessary to raise the former to the point of incandescence, that the combustion is entirely confined to the front of the grate, whence radiation into the room takes place, and that any heat reaching the back of the grate is conducted away and utilised in heating the incoming air, by which combustion in front of grate is supported; in this way greater brilliancy and considerable economy are realised.

One arrangement by which this is effected is represented in diagram 1 (see NATURE, vol. xxiii. p. 26). The iron dead plate *c* is riveted to a stout copper plate *a* facing the back of the fire-grate, and extending five inches both upwards and downwards from the point of junction. The dead plate *c* stops short about an inch behind the bottom bar of the grate to make room for a half-inch gas-pipe *f*, which is perforated with holes of about one-sixteenth of an inch placed at distances of one and a half inch along the inner side of its upper surface. This pipe rests upon a lower plate *d*, which is bent downwards towards the back so as to provide a vertical and horizontal channel of about one inch in breadth between the two plates. A trap-door *e*, held up by a spring, is provided for the discharge of ashes falling into this channel. The vertical portion of this channel is occupied by a strip of sheet copper about four inches deep, bent in and out like a lady's frill and riveted to the copper back piece. Copper being an excellent conductor of heat, and this piece presenting (if not less than a quarter of an inch thick) a considerable sectional conductive area, transfers the heat from the back of the grate to the frill-work in the vertical channel. An air current is set up by this heat, which, in passing along the horizontal channel, impinges on the line of gas flames and greatly increases their brilliancy. So great is the heat imparted to the air by this simple arrangement that a piece of lead of about half a pound in weight introduced through the trap-door into this channel melted in five minutes, proving a temperature exceeding 619° F. or 326° C. The abstraction of heat from the back has moreover the advantage of retarding the combustion of the coke there while promoting it at the front of the grate.

The sketch represents a fire-place at my office, in a room of 7200 cubic feet capacity facing the north. I always found it difficult during cold weather to keep this room at 60° F. with a coal fire, but it has been easily maintained at that temperature since the grate has been altered to the gas-coke grate just described.

In order to test the question of economy, I have passed the gas consumed in the grate through a Parkinson's 10-light dry gas-meter; the coke used is also carefully weighed.

The result of one day's campaign of nine hours is a consumption of 62 cubic feet of gas and 22 lbs. of coke (the coke remaining in the grate being in each case put to the debit of the following day). Taking the gas at the average London price of 3*s*. 6*d*. per 1000 cubic feet, and the coke at 18*s*. a ton, the account stands thus for nine hours :—

	d.
62 cubic feet of gas at 3*s*. 6*d*. per thousand	2·604
22 lbs. coke at 18*s*. a ton	2·121
Total	4·725

or at the rate of 0·525*d*. per hour. In its former condition as a coal-grate the consumption exceeded generally two and a half large scuttles a day, weighing 19 lbs. each, or 47 lbs. of coal, which at 23*s*. a ton equals 5·7*d*. for nine hours, being 0·633*d*. per hour. This result shows that the coke-gas fire, as here described, is not only a warmer but a cheaper fire than its predecessor; with the advantages in its favour that it is lit without the trouble of laying the fire, as it is called, and keeps alight without requiring to be stirred, that it is thoroughly smokeless, and that the gas can be put off or on at any moment, which in most cases means considerable economy.

A second and more economical arrangement as regards first cost is shown in diagram 2 (NATURE, vol. xxiii., pp. 92, 93), and consists of two parts, which are simply added to the existing grate, viz.: (1) the gaspipe *d* with a single row of holes of about $\frac{1}{16}$ inch diameter, 1·5 inch apart along the upper side inclining inward, and (2) an angular plate *a*, of cast iron, with projecting ribs *b*, extending from front to back on its under side, presenting a considerable surface, and serving the purpose of providing the heating surface produced by the copper plate and frill-work in my first arrangement. In using iron instead of copper it is necessary however to increase the thickness of these plates and ribs in the inverse ratio of the conductivity of the two metals, or as regards the back plate, from $\frac{1}{4}$ inch to $\frac{5}{4}$ inch according to the best determinations recently published by Sir W. Thomson. This thickness would be practically inconvenient, and in order to avoid it the construction of the grate had to be modified for cast iron.

An inclined plate fastened to the lower grate bar directs the incoming air upon the heating surfaces and provides at the same time a support for the angular and ribbed plate, which is simply dropped into its firm position between it and the back of the grate.

The front edge of the horizontal plate has vandyked openings *c*, forming a narrow grating, through which the small quantity of ashes that will be produced by combustion of the coke or anthracite in the front part of the grate discharge themselves down the incline towards the back of the hearth, where an open ash-pan may be placed for their reception.

In adapting the arrangement to existing grates, the ordinary grating may be retained to support the angular plate, which has in that case its lower ribs cut short, to the level of the horizontal grate.

But it may be asked, Are you sure that the coke and gas grate you advocate will do away with fogs and smoke? My answer is, that it would certainly do away with smoke, because the products of combustion passing away into the chimney are perfectly transparent. Mr. Aitken has, however, lately proved in an interesting paper read before the Royal Society of Edinburgh, that even with perfect combustion a microscopic dust is sent up into the atmosphere, each particle of which may form a molecule of fog. We have evidence, indeed, that the whole universe is filled with dust, and this is, according to Prof. Tyndall, a fortunate circumstance, for without dust we should not have a blue, but a pitch-black sky, and on our earth we should be, according to Mr. Aitken, without rain, and should have to live in a perpetual vapour bath. The gas fires would contribute, it appears, to this invisible dust, and we should, no doubt, continue to have fogs, but these would be white fogs, which would not choke and blacken us. It is not clearly shown what this fine dust, resulting from the combustion of gas, consists of, and it seems reasonable to suppose that in perfect combustion it will be avoided.

Granted the cure of smoke, it might still be questioned whether such a plan as here proposed could be carried out on so large a scale as to affect our atmosphere with the existing mains and other plant of the gasworks. If gas were to be depended upon entirely for the production of the necessary heat, as is the case with an ordinary gas and asbestos grate, it could easily be proved that the existing gas mains would not go far to supply the demand; each grate would consume from 50 to 100 cubic feet an hour, representing in each house a consumption exceeding many times the supply to the gaslights. My experiments prove, however, that an average consumption of from 6 to 8 cubic feet of gas per hour suffices to work a coke gas grate on the plan here proposed. This is about the consumption of a large Argand burner, and therefore within the limits of ordinary supply.

But independently of the practical question of supply, it is desirable on the score of economy to rely upon the solid carbon chiefly for the production of radiant heat for the following reason :—

1000 cubic feet of ordinary illuminating gas weigh 34 lbs., and the heat developed in their combustion amounts to $34 \times 22{,}000 = 748{,}000$ heat units.

One pound of solid coke develops in combustion, say, 13,400 heat units (assuming 8 per cent. of incombustible admixture), and it requires $\frac{748{,}000}{13{,}400} = 56$ lbs., or just half a hundredweight, of this coke to produce the same heating effect as 1000 cubic feet of gas. But 1000 cubic feet of gas cost on an average

3*s*. 6*d*. and half a hundredweight of coke not more than 6*d*. (at 20*s*. a ton), or only one-seventh part of the price of gas.

If heating gas was supplied at a much cheaper rate, it would in many cases be advantageous to substitute incombustible matter, such as balls of asbestos, for the coke or anthracite. The consumption of gas would in that case have to be increased very considerably, but the economical principle involved (that of heating the air of combustion by conduction from the back of the grate) would still apply, and produce economical results as compared with those obtained by the gas-asbestos arrangements hitherto used.

To illustrate the efficiency of this mode of heating the in-coming air by what is called waste heat, I will show you another application of the same principle which I have made very recently to the combustion of gas for illuminating purposes.

(*To be continued.*)

THE RECENT SEVERE WEATHER

IN a recent contribution to the literature of meteorology Mr. E. J. Lowe, F.R.S., endeavours to prove that droughts and great frosts are periodical, occurring at intervals of between eleven and twelve years. In support of this theory he remarks: "There can be no reasonable doubt that the cycles are more than eleven years and less than twelve (more nearly eleven than twelve)," and a table of "great frosts" is given, from which we take the dates for the present century in the same order as printed.

1801—2	1819—20	1860—61
1813—14	1837—38	1856—57
1810—11	1840—41	1870—71

The present year may now be added to the above list.

It will be noticed that there are some variations in the lengths of the intervening periods, but there is at the same time a distinct recurrence of eleven-year epochs.

The great frost of the month just ended will doubtless form one of the main features in the meteorology of the nineteenth century. In the table below are given the average temperatures of the United Kingdom for the three weeks ended January 10, 17, and 24 of the present year, together with the temperatures for the same weeks ended January 12, 19, and 26 of the year 1880. Each year the average for these periods was below the mean seasonal value. The deficiency is given in the fifth and tenth columns.

Districts.	1881. 1st week.	2nd week.	3rd week.	Average.	Below the mean.	1880. 1st week.	2nd week.	3rd week.	Average.	Below the mean.
	°	°	°	°	°	°	°	°	°	°
Scotland, East	30	24	25	26·3	11·7	38	34	34	35·3	2·3
England, N.E.	35	23	25	27·7	9·7	37	32	32	33·7	4·3
England, East	36	23	24	27·7	10·7	34	32	31	32·3	6·0
Midland Counties...	34	21	22	25·7	13·3	35	33	29	32·0	6·7
England, South......	37	26	26	29·7	10·3	35	32	30	32·3	7·0
Scotland, West	33	23	26	27·3	12·0	40	34	33	35·7	4·0
England, N.W.......	35	25	27	29·0	11·0	38	34	33	35·0	5·0
England, S.W.	38	31	28	32·3	10·3	39	38	35	37·1	6·3
Ireland, North	35	24	26	28·3	12·0	42	37	31	36·7	4·3
Ireland, South	38	27	27	30·7	10·7	43	37	35	38·3	3·3
London	37·4	24·2	24·8	28·8	10·3	34·2	32·4	29·1	31·9	7·1

The weather during the above periods was cold in both years, and the deficiency of solar heat is more noticeable, if the figures of the second and third weeks in each year are compared. On several days bright sunshine occurred for several hours, yet at some stations the sunshine was so weak as to fail to mark the recording cards of Prof. Stokes's sunshine recorders.

The weather over the whole of north-western Europe has been generally intensely cold, and on January 28 the temperature at Haparanda (extreme north of Gulf of Bothnia) was reported as being 60° F. below freezing point.

H. W. C.

THE AURORA OF JANUARY 31

WE have received the following communications on the recent brilliant display of aurora:—

HAVING noticed an auroral light through the mist on the evening of January 30, I looked out last evening, the 31st, and saw what to me at least was a new appearance. There was a strong yellowish-white auroral light in the north, with an uneven boundary—not a well-defined arch. From it there arose, at intervals of a minute or two, what looked like wisps of luminous mist of an elliptical form, with their longer axes east and west. These chased one another towards the zenith, appearing and disappearing with great rapidity, so that one could hardly say "look!" before they had vanished. Sometimes three or four were flashing out at once. They were of large size, and being unaccustomed to the description of such objects, I know not how to describe their size. They must however have subtended horizontally angles of 45° and more at the eye. This appearance lasted, from the time I first looked out at about 6h. 45m., for about ten minutes or less, and then the appearance gave place to ordinary streamers, yellowish-white at their base and rosy towards their summits.

The flashing lights which I have mentioned suggested to me this idea: One has seen two men shaking a carpet held at two adjoining corners. Their strokes not exactly coinciding, an irregular, undulatory movement is produced, something like the waves of a chopping sea. If a stratum of *something* was in such a state of undulation above the atmosphere, and became visibly luminous where the crests of the undulations dipped down into the atmosphere, it would produce the kind of appearance that I saw.

OSMOND FISHER

Harlton Rectory, Cambridge, February 1

LEST the magnificent auroral display of last evening has not been generally visible, the following short account of it, as witnessed here, may not be unacceptable to the readers of NATURE.

At about 6.15 p.m. indications of the disturbance were noticed in an unusually bright appearance of the sky from the north-east to north-west by west, the light being white, and similar in character to that reflected from the upper part of a bank of fog By 6.25 the upper limit of this phenomenon had gradually changed into a number of bands, alternately bright and dark, but not well defined, which after another short interval disappeared in a change of the light to a very ruddy tint, accompanied by a kind of throbbing in the north, exactly like rapid repetitions of faint lightning. At this period a great number of parallel bands of light of a beautifully clear salmon tint were extended from the ruddy bank in a southerly direction, those from the north passing beyond the zenith, and losing their definition in a diffused patch of light of the same colour. These bands slowly faded away, but were succeeded by a similar and equally beautiful display at from ten to fifteen minutes later.

About seven o'clock I walked two and a half to three miles in a northerly direction, and found in ascending a slight hill that the fog was sufficiently thick to obscure the stars. This I imagine explains the peculiar bank and thick appearance of the light near the horizon.

The whitish illumination in the same quarter of the sky was still visible at 12 p.m.

JOHN HARMER

Wick near Arundel, February 1

A BRILLIANT aurora borealis has been visible here this evening. It commenced at twenty minutes to seven, extending from west-north-west to a little east of north. The western part was of a deep ruddy colour, extending (at a rough estimate) some 35 or 40 degrees from the horizon, and varied by long white streamers, one of which—nearly due north—reached to within 15 or 20 degrees of the zenith. I was unable to watch it for more than a few minutes, but at half-past ten the sky in the same direction was still remarkably bright.

R. W. TAYLOR

Kelly College, Tavistock, January 31

A VERY brilliant auroral display was visible here last night. There was a short heavy shower of hail and rain at six o'clock, and the sky was entirely overclouded. Thirty minutes later the sky was again clear, and the northern horizon was beautifully illuminated, and broad quivering bands of light stretched from thence upward beyond the zenith, some in unbroken continuity, while others were broken up. Not connected with these rays, and on the south side of the zenith, were frequent flashes of light, usually crescentic in form. The light near the horizon was silvery and moonlight like, but higher up it became much ruddier. I watched the aurora from 6.30 till 7, when I was obliged to go in-doors till 10.30, and then able to observe it again. At that time the light near the northern horizon had greatly increased in brightness, but fewer bands extended